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HEMOGLOBINS TO MAINTAIN CELL ENERGY STATUS

This application is a National Phase entry of PCT CA99/00587, having an international filing date of June 24, 1999 and this application claims priority under 35 USC § 119(e) to USSN 60/106,638, filed November 2, 1998 and to USS 60/090,929, filed June 26, 1998

The present invention relates generally to the field of expression vectors and transgenic organisms.

BACKGROUND OF THE INVENTION

Hemoglobins are widespread throughout the biosphere (Wittenberg and Wittenberg, 1990, *Annu Rev Biophys Biophys Chem* 19:217-241). They are found in a broad range of organisms from bacteria, through unicellular eukaryotes, to plants and animals, suggesting that they predate divergence of life into plant and animal forms. Plant hemoglobins have been classified into symbiotic and nonsymbiotic types (Appleby, 1992, *Sci Progress* 76:365-398): symbiotic hemoglobins are found in plants that are capable of participating in microbial symbioses, where they function in regulating oxygen supply to nitrogen fixing bacteria; nonsymbiotic hemoglobins have only recently been discovered and are thought to be the evolutionary predecessors of the more specialized symbiotic leghemoglobins. The ubiquitous nature of nonsymbiotic hemoglobins is evidenced by their broad presence across the plant kingdom (Appleby, 1985, Nitrogen Fixation and CO_2 Metabolism, eds. Ludden and Burris, pp. 41-51) and the widespread presence and long evolutionary history of plant hemoglobins suggest a major role for them in the life of plants.

Specifically, plant hemoglobins have been known to exist in the root nodules of legumes for almost 60 years (Kubo, 1939, *Acta Phitochem* 11:195-200; Keilen and Wang, 1945, *Nature* 155:227-229). Over the years, hemoglobins have been positively identified in three non-leguminous dicotyledonous plants: *Parasponia andersonii*, *Tream tomentosa*, and *Casuarina glauca* (Appleby et al., 1983, *Science* 220:951-954; Bogusz et al., 1988, *Nature* 331:178-180; Kortt et al., 1988, *FEBS Lett* 180:55-60). Recently, an Hb cDNA from barley was isolated and the gene was demonstrated to be expressed in seed and root tissues under anaerobic conditions (Taylor et al., 1994, *Plant Mol Biol* 24:853-862), providing further evidence to support the contention that plant hemoglobins have a common origin (Landsmann et al., 1986, *Nature* 324:166-168). Since Hb has now been demonstrated to occur in two of the major divisions of the plant kingdom, it is likely